Student Name ______________________________
Date of Lab: ______________________________

Heat of Fusion for Ice

(Thermometer)

Concept: phase change

EQUIPMENT NEEDED

- 3 good quality laboratory thermometers
- Styrofoam calorimeter cup
- base and support rod
- beaker, 250 mL
- buret clamp
- platform balance for measuring mass
- slit stopper
- stirring rod
- tongs

CONSUMABLES NEEDED

- ice cubes
- warm water (60 C)

PURPOSE

The purpose of this laboratory activity is to calculate the energy required to melt one gram of ice and to determine the latent heat of fusion for ice.

THEORY

Melting and freezing behavior are characteristics that are used to identify unknown pure substances. When a substance experiences a phase change, the temperature does not rise or fall during the phase change. For example, as energy is added, pure solid water (ice) at 0 C changes to liquid water at 0 C. When the substance reaches its melting (or freezing point), energy that is added (or removed) is used to generate the phase change instead of raising (or lowering) the temperature. The name given to this amount of heat which appears to be "hidden" (in that no temperture rise takes place as it is being added) is **latent heat** (of fusion and vaporization) (Tables of phase change temperatures and latent heats of fusion and vaporization for pure substances can be found at your library.)

Therefore, to calculate a heat of fusion you must measure a ΔT of a surrounding material. In this experiment you will measure the temperature change of a beaker of water as the ice in the beaker melts. To calculate the heat that flows from the water, you can use the relationship

$$Q = C_p \cdot m \cdot \Delta T$$

where **Q** stands for *heat flow*, C_p is *heat capacity*, **m** is *mass* in grams, and Δ**T** is the *change in temperature*. For water, C_p is 1.00 cal/g C°.

PROCEDURE

For this activity, the thermometer measures the temperature of ice water.   We will have at least two thermometers available. We will also need to know the temperature of the room

1. Use a base and support rod, a buret clamp and a slit stopper to support the thermometer as shown.

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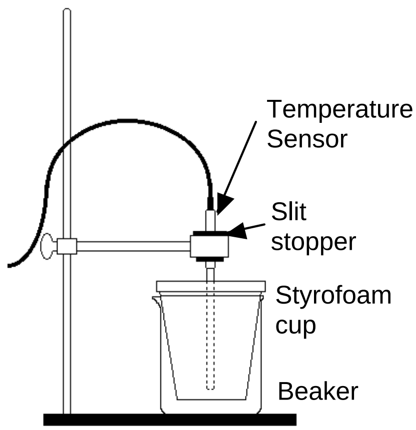
2. Place a Styrofoam cup into a 250 mL beaker.

3. Pour 100.0 mL of water at about 60 C into the Styrofoam cup.

4. Obtain 7 or 8 large ice cubes.

5. Lower the temperature sensor into the warm water (to about 1 cm from the bottom).



Heat of Fusion for Ice

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Data Recording:

1. Take the mass of the empty calorimeter cup. Then fill it part way (about a third of the way) with warm water (somewhere near 60°C)

2. Take the mass of the cup with the warm water in it. We will now know the amount of warm water that was used.

3. Determine the temperature of the hot water. This maximum will determine the initial temperature, T_1, of the water.

3. As soon as this maximum temperature is reached, fill the Styrofoam calorimeter cup with ice cubes.

4. Shake excess water from the ice cubes before adding them (or dry with a paper towel).

6. Use a stirring rod to stir the mixture as the temperature approaches 0 C.

Important: As the ice melts, if necessary, add ice cubes to keep the mixture cold.

7. Continue stirring until the temperature reaches about 3 or 4°C, quickly remove the unmelted ice (using tongs). Again, attempt to shake off any water and be sure that it winds up back in the calorimeter cup. This water, which may wind up being removed from the cup, will be the largest source of error in this lab, so do your best to not remove water with the ice.

8. After removing the ice, remeasure the temperature in the cup. It will probably be lower still than when you started removing the ice. This minimum temperature is the final temperature, T_2, of the water.

10. Determine the new mass of the calorimeter, the warm water and the melted ice. It should now be apparent to you how we can determine how much ice was melted.

ANALYZING THE DATA

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1. Subtract T_2 - T_1 to determine ΔT, the change in warm water temperature.

2. Find the mass of ice melted

3. Subtract 0 from T_2 to determine how much the melted ice water warmed up after melting.

4. Calculate the energy (in calories) released by the 100 g of liquid water as it cooled ($q = C_p \cdot m \cdot \Delta T$).

5. Calculate the energy (in calories) absorbed by the ice water as it warmed up to T_2.

6. Calculate the energy (in calories) absorbed by the melted ice water to warm to the final temperature, T_2.

7. The remainder of the heat given up by the warm water was used to melt the ice. Now calculate the heat of fusion, the energy required to melt one gram of ice (in cal/g of H_2O).

DATA TABLE: HEAT OF FUSION

Item	Value
Initial water temperature, T_1 (°C)	°C
Final water temperature, T_2 (°C)	°C
Change in water temperature, ΔT (C°)	C°
Mass of empty calorimeter (g)	g
Mass of calorimeter and warm water (g)	g
Mass of calorimeter, warm water and ice (g)	g
Mass of melt, (g)	g
Heat released by cooling water ($q = C_p \cdot m \cdot \Delta T$)	cal
Heat absorbed by melted ice to come to T_2	cal
J/g ice melted (heat of fusion)	cal/g
Percent difference	%

QUESTION

1. What is your percent difference for the latent heat of fusion value? (The accepted value for latent heat of fusion is 79.7 cal/g

Remember, $$\text{percent difference} = \left|\frac{\text{accepted - measured}}{\text{accepted}}\right| \times 100\%$$